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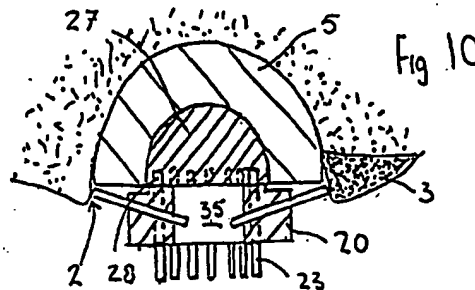
(71) Applicant:
HOWMEDICA INTERNATIONAL INC.
Shannon Co. Clare (IE)

(72) Inventor:
Lawes, Peter,
"Kingsmede"
Maidenhead, Berkshire. SL6 4DB (GB)

(74) Representative:
Bridge-Butler, Alan James et al
G.F. Redfern & Co.,
7 Staple Inn,
Holborn
London WC1V 7QF (GB)

(54) **Profile gauge for measuring and indicating the profile of bone openings**

(57) A profile gauge for use with a device which has a skirt or flange which can be trimmed and which is adapted to co-operate with the periphery of an opening in a bone characterised by adjustable means for measuring and indicating the diametric profile of the mouth of rim area adjacent thereto of the bone opening, and means for removably locating said adjustable means on said device to indicate on the skirt or stem thereof the measured diameter profile.



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Description

This invention relates to a profile gauge for measuring and indicating the diametric profile of a bone opening and is particularly, although not exclusively, applicable for use with a device having a skirt or flange which can be trimmed and which is adapted to cooperate with the periphery of the bone opening, for example, an acetabular cup loading tube which is provided with a skirt or a flanged acetabular cup.

In certain surgical operations it is convenient to be able to measure the diametric profile of a bone opening, for example if a plate of specific size is to be used or if an acetabular cup is to be implanted into an acetabular socket.

EP-A-0 650 706 and EP-A-0 650 707 both show apparatus for implanting an acetabular cup employing a loading tube adapted for alignment with an acetabular socket, the bore of said tube being dimensioned to receive an acetabular cup as a sliding fit to guide it into the socket and the present invention can provide a profile gauge which can be used with such a loading tube.

If a rim cutter is used to produce a step inside the bony rim of a natural acetabulum two problems can arise. Firstly it demands a very high level of surgeon patience, care, calmness, experience, determination and skill to position the cutter accurately and hold it on course. Otherwise, the cutter can cut eccentrically and find its own orientation. Secondly, many acetabulae are insufficiently circular to allow the rim cutter to prepare a ledge around much more than about 180° and this does not permit a loading tube to seat and seal.

Furthermore, where in revision surgery, bone chips are used to reform the acetabulum the rim cutter cannot cut the recess in a bed of loose morsels of bone. Sometimes a bone graft is contained in a surgeon formed metal mesh which in turn can be anchored by bone screws. With this arrangement a rim cutter must not be used to cut this metal mesh inside the patient.

In order to overcome the difficulties the proposed solution for both non-circular and bone chip acetabular rims is to avoid the rim cutting operation and to trim the skirt of the loading tube so that it accurately fits the bony (or grafted) acetabular rim. Thus the skirt can be trimmed to fit either within the rim or around it.

Flanged acetabular cups are known and are held in place in the acetabular socket by cement. There are various types but they all have a peripheral flange which is usually supplied by an oversized shape and is then cut to fit the rim of the acetabular socket with which it is to be used. Once again it is desirable to be able to prepare the flange so that it accurately fits the bony (or grafted) acetabular rim of the socket. Once again the flange can be trimmed to fit either within the rim or around it.

The present invention offers a profile gauge to assist in trimming the overlapping material of the skirt of a tube or the flange of a flanged cup.

There are other devices which also employ overlap-

ping skirts or flanges used in orthopaedic surgery to which the present invention is also applicable.

According to one aspect of the present invention therefore a profile gauge for use with a device which has a skirt or flange which can be trimmed and which is adapted to co-operate with the periphery of an opening in a bone is characterised by adjustable means for measuring and indicating the diametric profile of the mouth of rim area adjacent thereto of the bone opening, and means for removably locating said adjustable means on said device to indicate on the skirt or stem thereof the measured diameter profile.

The device can, for example, be an acetabular cup loading tube provided with a skirt, said bone opening being an acetabular socket, and said adjustable means being adapted to measure and indicate the diametric profile of the mouth of the rim area adjacent thereto of said acetabular socket into which an acetabular cup is to be implanted.

Again, the device can be a flanged acetabular cup, said bone opening can be an acetabular socket, and the adjustable means can be adapted to measure and indicate the diametric profile of the mouth of the rim area adjacent thereto of said acetabular socket into which said acetabular cup is to be implanted.

With these arrangements the profile gauge can be used to measure the socket and the measurement can be transferred accurately to the skirt of the loading tube or to the flange of the cup.

Preferably the adjustable means includes a body portion and a number of peripherally projecting indicators which can be adjusted to define the shape of the mouth of the bone opening.

The indicators can thus be provided by axially movable pins and these can be held in place by friction between each pin and the body portion.

The body portion can be substantially annular, the indicators projecting outwardly from the periphery thereof and also inwardly into the central opening.

Preferably the means for removably locating said adjustable means includes a plug adapted to engage and fit within the bore of the loading tube with which the gauge is to be used and said plug can be removable from said adjustable means.

The gauge can be provided with means for axially locating it in relation to the mouth of the bone opening to be measured.

Thus the bone opening locating means can include a trial cup and can include a cup plug which can be located on or in said trial cup and to which the adjustable means is connected.

The connection between the cup plug and the adjustable means can be detachable.

In a preferred construction said projecting indicators have a dished configuration adapted to be substantially parallel to the projecting angle of the skirt on the loading tube or the flange of the flanged cup with which they are to be used.

According to another aspect of the present invention a profile gauge for measuring and indicating the diametric profile of a bone opening or the rim area adjacent thereto comprises a body portion and a number of peripherally projecting indicators which can be adjusted to define the profile or the rim area adjacent thereto of the opening in the bone to be measured.

Thus, with this construction the general arrangement can be similar to that set forth above with or without means for locating the adjustable means in the bone opening to be measured.

The invention can be performed in various ways and some embodiments will now be described by way of example and with reference to the accompanying drawings in which :

Figure 1 is a diagrammatic cross-sectional view showing an idealised acetabular form;

Figure 2 is a similar view showing an eroded acetabular form;

Figure 3 is a similar view showing a reconstructed acetabular form;

Figure 4 is a diagrammatic view showing the employment of an oversized trial cup;

Figure 5 is a similar diagrammatic view showing the use of orientation alignment pointers;

Figure 6 is a similar view showing how the socket can be marked;

Figure 7 shows how orientation alignment pointers can be used on a loading tube;

Figure 8 is a side elevation of a profile gauge according to the present invention and which can be used in the operation for installing the cup;

Figure 9 is a plan view of the profile gauge shown in Figure 8;

Figure 10 is a cross-sectional side elevation showing how the profile gauge shown in Figure 8 and 9 can be used for measuring the profile of an acetabular socket;

Figure 11 is a view similar to Figure 10 showing an alternative use of the profile gauge;

Figure 12 is a cross-sectional side elevation showing how the profile gauge shown in Figures 8 and 9 can be used to transfer the profile shape to the skirt of a loading tube;

Figure 13 is a diagrammatic plan view showing how

a profile gauge of the kind according to the invention can be used to transfer the dimensions of an acetabular opening to a flanged cup to enable the flanges thereon to be cut to shape;

Figure 14 is a diagrammatic side view of the gauge as applied to a flanged cup;

Figure 15 is a diagrammatic side elevation of a flanged cup in position in an acetabular socket;

Figure 16 is a plan view of a profile gauge which can be used for a bone opening, for example, for measuring the diametric profile of the medullary canal of a tibia; and,

Figure 17 is a cross-sectional side elevation on the line XVI-XVI of the device shown in Figure 16 in place in a medullary canal.

As shown in Figure 1 an idealised acetabular socket is substantially symmetrical and it is substantially regular around the periphery of its rim 2 although medially there is always a substantial departure from this regularity (not shown in Figure 1). Figure 2 shows how the rim 2 can become eroded.

Figure 3 shows how a surgeon can build up the rim by the use of, for example, morselised bone grafting indicated by reference numeral 3. The reconstruction of the acetabular forms often includes the use of metal mesh which is frequently anchored using bone screws, but no bone screws are shown in the drawing.

When an acetabular cup is to be inserted into an eroded acetabular socket as shown in Figure 2 the surgeon first prepares the acetabulum with or without morselised bone grafting depending upon the precise state of the socket. Although the socket may be eroded it might be possible to insert a prosthetic cup without bone grafting.

An oversized trial acetabular cup 5 is placed into the prepared acetabulum 6. This trial cup is oversized to allow for the thickness of the cement mantle.

The trial cup can now be orientated and fitted in the pelvis to check for position and angulation and to perform a trial reduction of the hip, using an acetabular cup inserter 7 as shown in Figure 5 which can be fitted, for example by means of pegs 8 or other suitable means, to the trial cup 5 and carrying vertical and horizontal pointers 9 and 10. This type of adjustable pointer is well known in the industry and will not therefore be described further.

A profile gauge 20, as shown in Figures 8 and 9, and which will be described in more detail hereunder, can now be used in the manner described with regard to Figures 10 and 11 to accurately measure the rim 2 of the socket.

Where there is morselised bone grafting the profile gauge can be used to measure beyond the bone chips

and record the profile of the hard bony rim rather than that inside the graft.

The profile gauge 20 and trial acetabular cup 5 are now removed from the patient.

The profile gauge is attached to the skirt 30 of a loading tube 31 and the skirt is trimmed to match the profile of the acetabulum.

In the arrangement shown in Figure 11 the flange is an integral part of the loading tube but it can be separate so that it can be assembled to the tube by the surgeon.

The loading tube 31 and skirt 30 are now fitted to the acetabulum as shown in Figure 7 and pointers 32 and 33 mounted on the tube 31 are used to copy the chosen orientation as determined by the pointers 9 and 10 and as shown in Figure 5. Alternatively, the acetabulum can be marked, for example with methylene blue, a commonly used marker, as shown by reference numeral 34 in Figure 6, to show the depth of the flange at several points around the rim 2.

The flange can thus be arranged to sit inside the bone grafting (if present) as shown in Figure 7 leaving it exposed or it can be arranged to overlay the bone grafting and allow cement to pass under the flange but cover the graft.

The cup is now inserted in the manner described in EP-A-0 650 706 and EP-A-0 650 707, that is the prepared acetabulum is filled with cement through the tube 31, the cement being pushed into place by a manually operated inserter in the form of a piston (not shown in the drawings of the present invention). The piston is removed when the cement is partially set at an adequately "doughy" stage. The cup to be inserted is immediately passed down the tube by the same or a different inserter and thus the cement is pressurised from the moment the cup touches it, or the cement may need to first flow to exclude all air spaces before pressurisation occurs.

A cement flow release arrangement can be provided by the provision of an orifice (not shown) in the skirt 30. The hole in the skirt is occluded, for example by the surgeon's thumb, to thus allow the pressure to build up and then allow excess cement to escape.

With the cup in place and the cement fully cured the tube is cut away and the remainder of the skirt can be left implanted or removed.

All the different constructions shown in EP-A-0 650 706 and EP-A-0 650 707 can be incorporated into the tube used in the method described herein.

It will thus be appreciated that the tube acts as a loading and guide tube for the cup.

The construction of a profile gauge which forms the subject of the present invention is shown in Figures 8 to 12.

The gauge 20 comprises adjustable means for measuring and indicating the diametric profile of the rim 2 of the acetabular socket and includes a body portion formed by a substantially circular annulus 21 which can

be of a plastics material or metal. Mounted in the annulus are a series of peripherally projecting indicators provided by radially extending pins 22 which are orientated so that they provide a dished configuration. The pins are held by friction as a relatively tight sliding fit in the annulus 20 so that they can be pushed in and out radially from one end or the other to define the shape of the rim of the socket as explained hereunder and so that the pins hold their position during removal of the gauge from the patient during the process of transferring the profile.

The body portion provided by the annulus 21 also carries a ring of locating rods 23 the ends 24 of which project outwardly from a flat surface 25 of the annulus and provide part of the means for accurately locating the measuring means in relation to the mouth of the socket to be measured. The other ends 26 of the rods 23 project from an opposed flat surface of the annulus and provide part of the means for removably locating the adjustable means provided by the annulus 21 or the pins 22 on the loading tube 31.

It will be appreciated that there are numerous ways of constructing the gauge, for example, it could be of two parts which are held together by the rods 23. Again, the annulus itself could be dished with the radial pins 22 being aligned within it.

A construction could also be devised in which the pins 22 are not dished but merely project radially outwardly although dishing is a convenient construction. Again the angle of dishing around the gauge could vary to match the angle of the skirt on the tube or flange on the cup to be used.

Figures 10, 11 and 12 show how the profile gauge is used. The same reference numerals are used in Figures 10 and 11 to indicate parts shown in Figures 1 to 7. The means for accurately locating the adjustable means in relation to the rim of the socket to be measured include the trial cup 5 and a cup plug 27 which can be located in the trial cup 5 and which has a ring of sockets 28 into which the ring of rods 23 can fit to hold the annulus 20 accurately in position.

With the adjustable means held in this way the pins 22 are pushed outwardly until they engage the rim 2 of the socket to thus provide the shape of an outline. The provision of the openings 35 in the annulus 21 provides access to the inner ends of the pins 22.

Figure 11 shows how the surgeon can record the profile over the top of the rim, which in this case is formed on one side by the morselised bone grafting 3.

The plug 27 is now removed complete with the adjustable means and the ends 26 of the rods 23 are pushed into a loading tube plug 29 which is adapted to engage and fit within the bore 36 of the loading tube 31. The plug 29 is pushed into the bore until the pins 22 engage the skirt 30 and the shape thus defined thereon can either be marked or the skirt can be trimmed by the surgeon with the adjustable means in place.

If desired the cup plug 27 can be removed before

inserting the plug 29 into the bore 36 of the tube 31.

It will be seen that the dished configuration of the projecting indicators provided by the pins 22 ensure that they are substantially parallel to the projecting angle of the skirt 30 on the loading tube 31 with which they are to be used.

The cement mantle will be typically 3 mm all around the implanted cup. The cup need have no integral flange. Therefore the 3 mm cement thickness will be generated by a 1 mm tube wall thickness plus 2 mm of tube skirt (plus additional skirt depth which might overlay any bone grafting).

If the skirt is to overlay any bone grafting then the shape of the skirt can be cut slightly larger than that indicated by the pins 22 at that point or it can be measured as shown in Figure 11.

Figures 13 to 15 show a modified form of profile gauge according to the invention which can be used to measure and indicate the diametric profile of an acetabular socket and which can be used to transfer the shape to the flange of a flanged type acetabular cup so that the flange can be cut to accurately engage within the socket.

In this construction the same reference numerals are used to indicate similar parts to those in Figures 8 to 12.

Flanged acetabular cups are known and are held in place in the acetabular socket by cement. In Figures 13 and 14 the flanged acetabular cup is indicated by reference numeral 37 and its flange by reference numeral 38. The flange is usually supplied as an oversize shape and is then cut to fit the rim 2 of the acetabular socket.

In some flanged cup constructions (for example the OGEE type cup) the cup flanges have a varying angle of dishing around the circumference in which case the dishing angle of the pins 22 can also be varied to suit the type of cup with which the gauge is to be used.

The profile gauge is initially used to measure the rim of the socket in the manner shown in Figure 10, that is by employing a trial cup and using a cup plug 27. When the pins 22 have been moved to their positions the cup plug is removed and placed in the socket of the flanged cup 37 as shown in Figure 13. The shape of the required flange is now indicated, as shown in Figure 13, where the desired shape is indicated by broken line 39. The line can either be marked or the flange can be trimmed by the surgeon with the gauge in situ. The parts of the flange which are removed are indicated in Figure 14 by reference numeral 39a. With the flange cut to shape the cup can now be inserted into the prepared acetabular socket and held by cement as shown in Figure 15.

It will be appreciated that the gauge can be used without a trial cup by being freely held in position whilst the pointers are adjusted. Preferably however the acetabulum is filled with something on which the gauge can locate.

In Figure 15 a bone grafted portion 3 is shown but

the process and gauge can of course be employed with cups for use with flanged cups for use in sockets which are in better condition.

As will be seen from Figure 14 the gauge includes locating rods 23 which have projecting upper portions 24. In this construction however the lower portions can be deleted.

If however the gauge was designed exclusively for use with flanged cups then the plug 27 could be incorporated into the main body portion 20 and the pins 23 would not be required.

Any sort of eccentricity of the cup or the flange can be catered for, for example an OGEE flange, an eccentric bearing surface within the cup, or a Charnley high posterior wall design, where the chamfered entry to the cup bearing surface is interrupted leaving a posteriorly placed ledge. In order to assist in use a coloured pin or a larger pin or some other circumferential marker can be used which will enable the surgeon to circumferentially match the profile gauge with the flange before trimming. This applied to both cup flanges and tube skirts.

Figure 16 shows a profile gauge for measuring and indicating a diametric profile of a bone opening and which is constructed in a somewhat similar manner to that described with regard to Figures 8 to 12. Thus the device comprises a substantially circular body portion 40 and a number of peripherally projecting indicators 41. Each indicator is in the form of a radially extending pin 42 the outer end of which projects beyond the outer rim 43 of the main body portion 40 and the inner end of which extends upwardly to provide an operating handle 44 as is most clearly shown in Figure 17.

The centre portion 45 of the main body portion is recessed to provide an upwardly projecting rim 46 in which the pins 42 are located. The pins 42 are held by friction as a relatively tight sliding fit in the rim portion 46 so that they can be pushed in and out radially by means of the handles 44 to define the shape of the opening in which they are placed.

In Figure 13 the gauge is located in a medullary canal indicated by reference numeral 47 and if desired a centralising plug indicated by chain lines 48 can be provided, the plug being attached by any convenient means to the main portion 40.

Alternatively the plug could be incorporated into the main body portion 40 as required.

In the construction shown in Figures 16 and 17 the main body portion 40 is circular but it could be any convenient shape, for example rectangular, triangular, elongated or oval depending upon the particular use for which the gauge was required. The projecting indicators could be angled in the main body portion to provide a disc configuration if this was more convenient for the requirement.

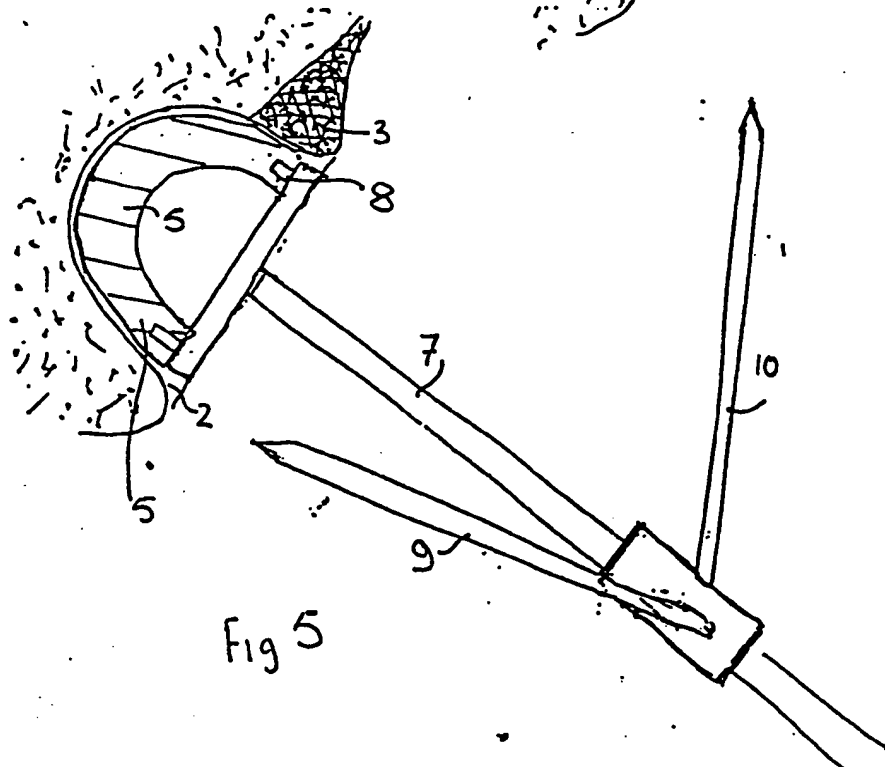
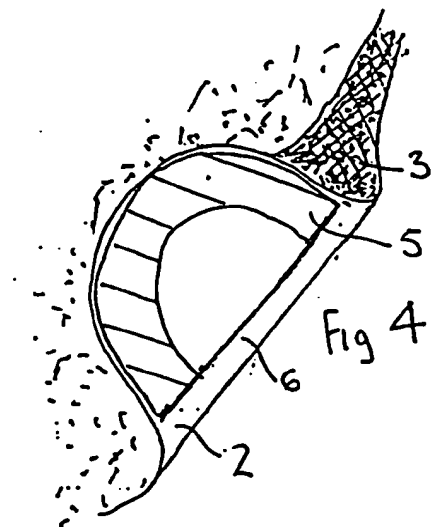
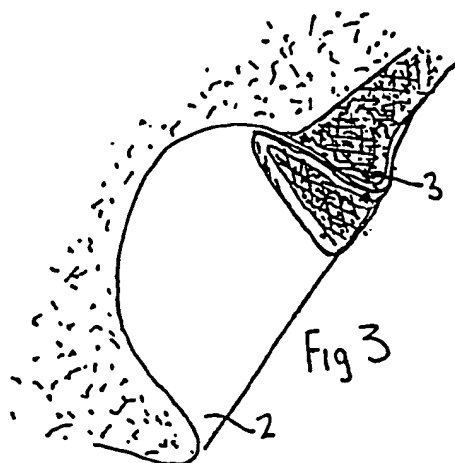
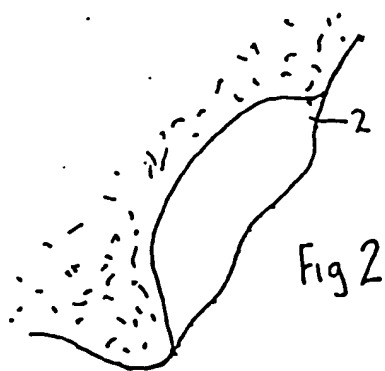
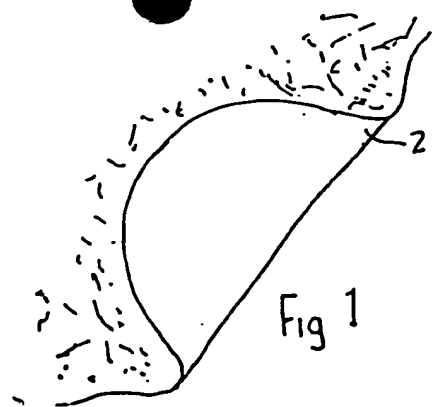
In an alternative construction the profile gauge could be substantially as shown in Figures 8 and 9 with or without means for attaching it to other members for centralisation, that is the main body portion could be

annular but of any convenient shape in plan view.

be used.

Claims

1. A profile gauge for use with a device which has a skirt or flange which can be trimmed and which is adapted to cooperate with the periphery of an opening in a bone characterised by adjustable means for measuring and indicating the diametric profile of the mouth of rim area adjacent thereto of the bone opening, and means for removably locating said adjustable means on said device to indicate on the skirt or stem thereof the measured diameter profile.
2. A profile gauge as claimed in claim 1 characterised in that said device is an acetabular cup loading tube provided with a skirt said bone opening is an acetabular socket and said adjustable means are adapted to measure and indicate the diametric profile of the mouth of the rim area adjacent thereto of said acetabular socket into which an acetabular cup is to be implanted.
3. A profile gauge as claimed in claim 1 characterised in that said device is a flanged acetabular cup, said bone opening is an acetabular socket and the adjustable means are adapted to measure and indicate the diametric profile of the mouth of the rim area adjacent thereto of said acetabular socket into which said acetabular cup is to be implanted.
4. A profile gauge as claimed in claim 1, claim 2 or claim 3 characterised in that the adjustable means includes a body portion and a number of peripherally projecting indicators which can be adjusted to define the shape of the mouth of the bone opening.
5. A profile gauge as claimed in claim 4 characterised in that said indicators are provided by axially movable pins.
6. A profile gauge as claimed in claim 5 characterised in that said pins are held in place by friction between each pin and the body portion.
7. A profile gauge as claimed in any one of preceding claims 4 to 6 characterised in that said body portion is substantially annular, the indicators projecting outwardly from the periphery thereof and also inwardly into the central opening.
8. A profile gauge as claimed in any one of preceding claims 2 to 7 characterised in that said the means for removably locating said adjustable means includes a plug adapted to engage and fit within the bore of the loading tube with which the gauge is to
9. A profile gauge as claimed in claim 8 characterised in that said plug is removable from said adjustable means.
10. A profile gauge as claimed in any one of the preceding claims characterised by means for axially locating it in relation to the mouth of the bone opening to be measured.
11. A profile gauge as claimed in claim 10 characterised in that the bone opening locating means includes a trial acetabular cup.
12. A profile gauge as claimed in claim 11 characterised by including a cup plug which can be located on or in said trial cup and to which the adjustable means is connected.
13. A profile gauge as claimed in claim 12 characterised in that the connection between the cup plug and the adjustable means is detachable.
14. A profile gauge as claimed in any one of the preceding claims characterised in that said projecting indicators have a dished configuration adapted to be substantially parallel to the projecting angle of the skirt on the loading tube or the flange of the flanged cup with which they are to be used.
15. A profile gauge for measuring and indicating the diametric profile of a bone opening or the rim area adjacent thereto characterised by comprising a body portion and a number of peripherally projecting indicators which can be adjusted to define the profile or the rim area adjacent thereto of the opening in the bone to be measured.



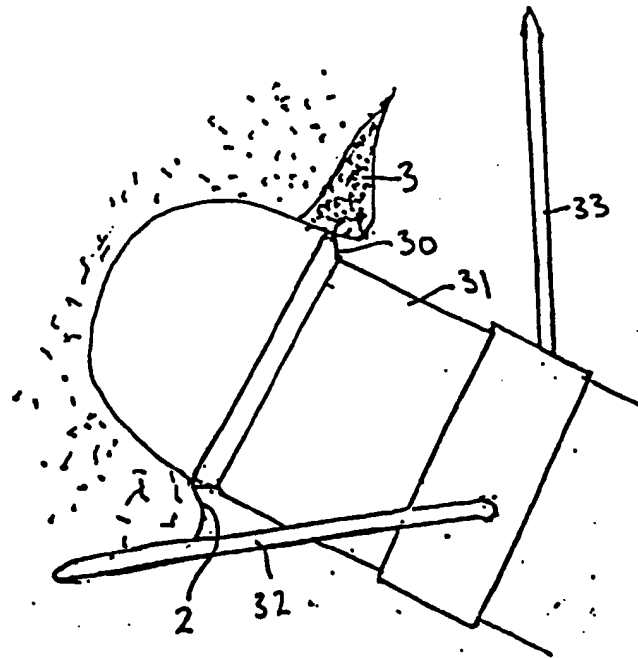
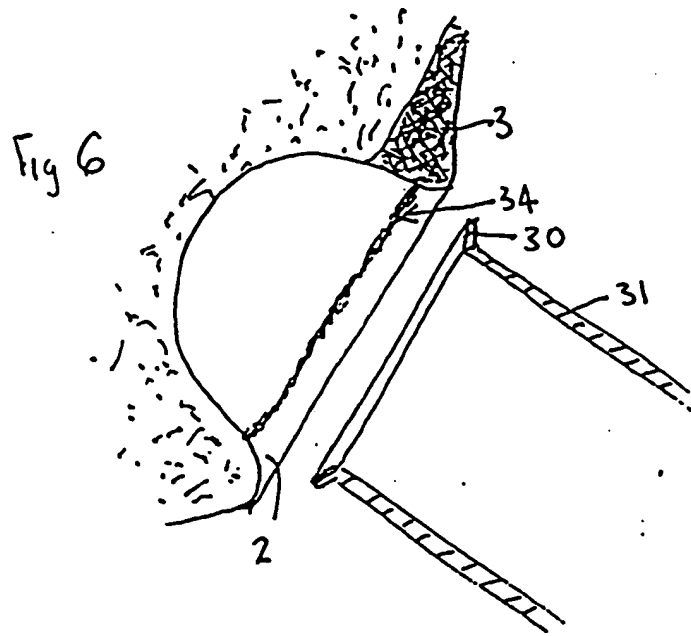
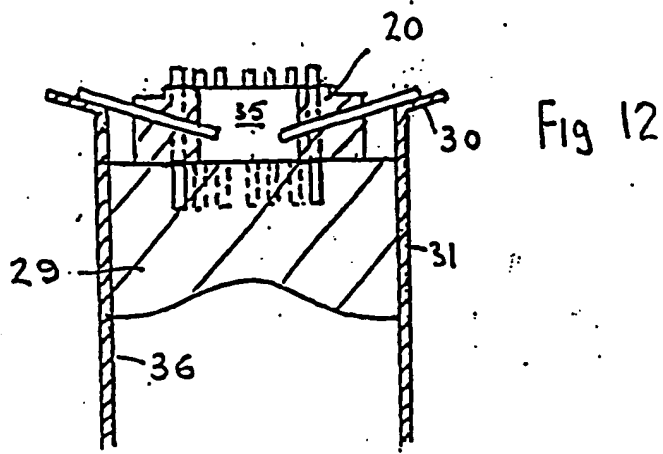
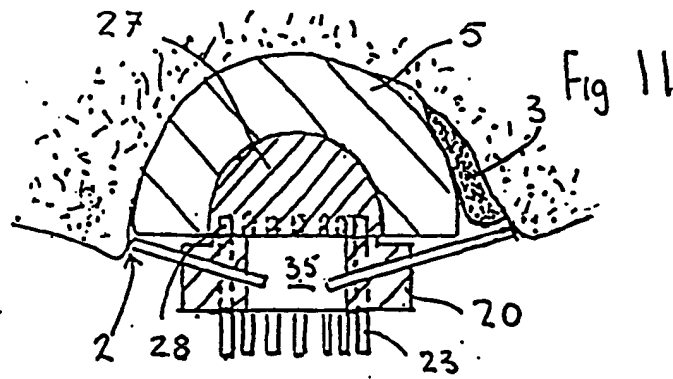
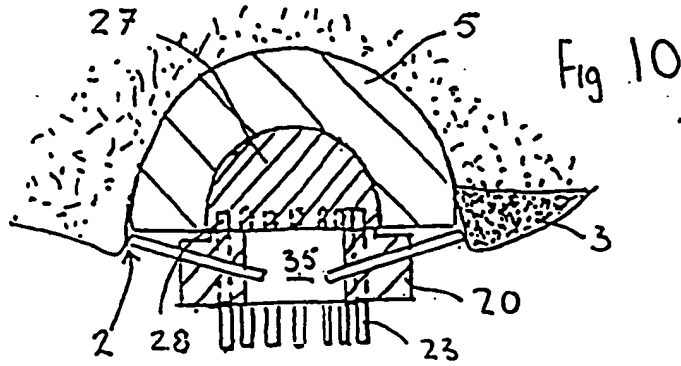
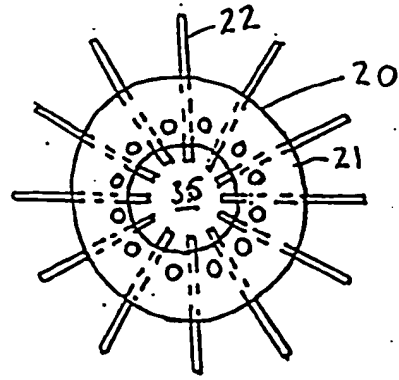
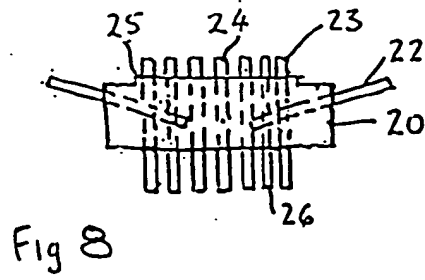
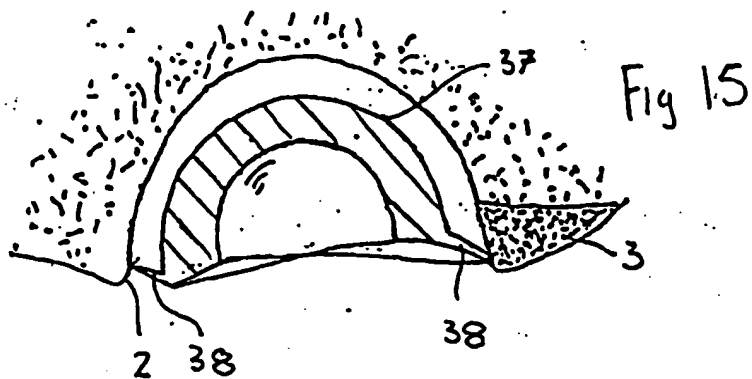
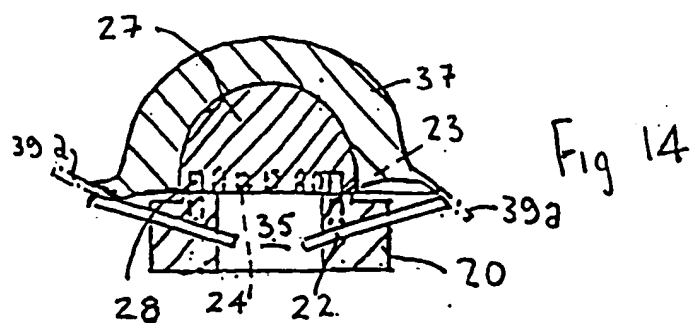
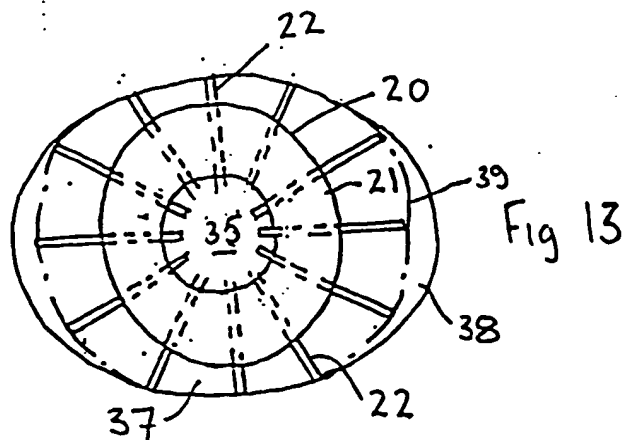


Fig 7





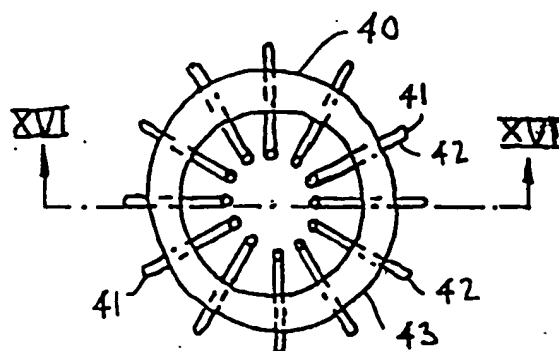


Fig 16

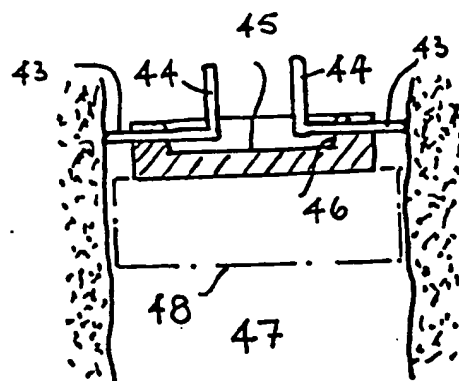


Fig 17